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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/698,964

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Kenneth O. McElrath

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EXAMINER

ONEILL, KARIE AMBER

ART UNIT

PAPER NUMBER

1795

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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

<b>Office Action Summary</b>	<b>Application No.</b> 10/698,964	<b>Applicant(s)</b> MCEL RATH ET AL.	
	<b>Examiner</b> Karie O'Neill	<b>Art Unit</b> 1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 22 April 2008.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1,4,6,8-17 and 63 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1, 4, 6, 8-17, 63 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 31 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)          | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____  | 6) <input type="checkbox"/> Other: _____                          |

### **DETAILED ACTION**

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on April 22, 2008, has been entered.

Claim 1 has been amended. Claims 2-3, 5, 7 and 18-62 have been canceled. Therefore, Claims 1, 4, 6, 8-17 and 63 are pending in this office action.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 6, 8-17 and 63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smalley et al. (US 2005/0249656 A1) in view of Hampden-Smith et al. (US 2003/0198849 A1).

With regard to Claims 1, 6 and 63, Smalley et al. discloses forming a patterned array of single-walled carbon nanotubes (SWNT) wherein the SWNT are derivatized with a functional group (paragraph 0011) and may be used in conjunction with carbon

black (paragraph 0059). The single walled carbon nanotubes have a diameter ranging from about 0.6nm up to 3nm, 5nm, 10nm, 30nm, 60nm or 100nm (paragraph 0064). The SWNT and carbon black form a planar mat or "bucky paper" having a thickness of about 100 microns (paragraph 0099). Smalley et al. discloses a catalyst metal comprised of platinum, in contact with the mat of carbon nanotubes. Smalley et al. also discloses wherein the catalyst metal further comprises one or more of the Group VI or VIII transition metals, specifically ruthenium, chromium, molybdenum, tungsten, iron, cobalt, nickel, rhodium, palladium, osmium and iridium (paragraphs 0161-0162). The SWNT exhibit a high level of conductivity, fewer defects than multi-walled carbon nanotubes and are very strong (paragraph 0058).

Smalley et al. does not disclose the use of the SWNT to form a fuel cell electrode for use in a proton exchange membrane fuel cell or a direct methanol fuel cell. Smalley et al. also does not disclose wherein the catalyst metal is present in an amount less than 400  $\mu\text{g}/\text{cm}^2$  of the planar area of the mat of carbon nanotubes and carbon black and wherein the electrode provides greater than 1  $\text{mA}/\text{cm}^2$  per  $\mu\text{g Pt}/\text{cm}^2$  of the planar area of the mat of carbon nanotubes and carbon black.

Hampden-Smith et al. discloses electrocatalyst powders for use as electrodes in fuel cells (paragraph 0027). Hampden-Smith et al. discloses the use of homo- and hetero-fullerene and carbon nanotube based materials as active components in the reduction of oxygen (paragraph 109). Hampden-Smith et al. also discloses an electrode structure utilizing platinum as the catalyst and having various surface loading values such as of 0.4  $\text{mg Pt}/\text{cm}^2$  (paragraph 417) and supported active species (platinum

Art Unit: 1795

electrocatalyst) loading of  $0.1 \text{ mg/cm}^2$  and a current density of  $150 \text{ mA/cm}^2$  (paragraph 38). Therefore, the electrode provides greater than  $150 \text{ mA/cm}^2$  per  $100 \text{ pg/cm}^2$  of the area of the carbon nanotubes.

Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use a catalyst metal present in an amount less than  $400 \text{ } \mu\text{g/cm}^2$  and wherein the electrode provides greater than  $1 \text{ mA/cm}^2$  per  $\mu\text{g Pt/cm}^2$  of the planar area of the mat of carbon nanotubes of Smalley et al., because Hampden-Smith et al. teaches that the performance of the electrode is primarily judged by reference to the relationship between the cell potential and the current density (paragraph 279, Figure 10) and it is advantageous to achieve a higher current density at a higher voltage and to maximize cell performance at low platinum loading (paragraph 286). Hampden-Smith et al. also teaches that using the absolute minimum amount of platinum catalyst is necessary for proper cell performance, reduces the cell weight and increases the power density of the fuel cell.

With regard to Claims 8-11, Hampden-Smith et al. discloses an electrode structure utilizing platinum as the catalyst and having various surface loading values such as  $0.1 \text{ mg Pt/cm}^2$  (paragraph 417) and  $0.05 \text{ mg Pt/cm}^2$  (paragraph 416). Hampden-Smith does not explicitly teach an electrode with a surface loading of  $0.025 \text{ mg Pt/cm}^2$  or  $0.010 \text{ mg Pt/cm}^2$ , however, at the time of the invention it would have been obvious to one having ordinary skill in the art to use the absolute minimum amount of platinum catalyst in the electrode of Smalley et al., because Hampden-Smith et al. teaches this being necessary for proper cell performance and the decrease in the total

Art Unit: 1795

amount of catalyst required reduces cell weight and increases the power density of the fuel cell. The comparisons discussed in Hampden-Smith et al. evaluate cell performance employing various surface loading values. The comparisons concluded that the cell performance was virtually identical for a cathode loading of 0.1 mg Pt/cm<sup>2</sup> and a catalyst loading of 0.4 mg Pt/cm<sup>2</sup> (paragraphs 415-417). The courts have held that the determination of optimum values of cause effective variable such as catalyst surface loading values require only ordinary skill in the art. See MPEP 2144.05.

With regard to Claims 12, 13 and 17, Hampden-Smith et al. discloses in one embodiment, a proton exchange membrane fuel cell (PEMFC) utilizing the electrocatalyst electrodes for chemical reactions (paragraphs 0101, 0313), and in a second embodiment, Hampden-Smith et al. discloses utilizing a direct methanol fuel cell (DMFC) (paragraph 0314). Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use either a PEMFC or DMFC with the electrode of Smalley et al., because Hampden-Smith et al. teaches that one of the critical requirements for these energy devices is the efficient catalytic conversion of the reactants to electrical energy. A significant obstacle to the wide-scale commercialization of such devices is the need for highly efficient electrocatalyst materials for this conversion process.

With regard to Claims 14-16, Hampden-Smith et al. discloses a membrane electrode assembly (MEA) having a supported active species (platinum electrocatalyst) loading of 0.1 mg/cm<sup>2</sup> and a current density of 150 mA/cm<sup>2</sup> (paragraph 38). Therefore, the electrode provides greater than 150 mA/cm<sup>2</sup> per 100 µg/cm<sup>2</sup> of the area of the

carbon nanotubes. Hampden-Smith discloses that the performance of the MEA is primarily judged by reference to the relationship between the cell potential and the current density (paragraph 279, Figure 10). Therefore, it is advantageous to achieve a higher current density at a higher voltage and to maximize cell performance at low platinum loading (paragraph 286). Although the current density is not explicitly stated as greater than 10, 50, or 100 mA/cm<sup>2</sup> per µg/cm<sup>2</sup>, it would have been obvious to one having ordinary skill in the art at the time of the invention to optimize the performance of the MEA (see Claims 66-70 of Hamden-Smith et al.). It has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. See MPEP 2144.05.

4. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smalley et al. (US 2005/0249656 A1) and Hampden-Smith et al. (US 2003/0198849 A1), as applied to Claims 1, 6, 8-17 and 63 above, and in further view of Fisher et al (US 6,203,814 B1).

Smalley et al. and Hampden-Smith et al. disclose the fuel cell electrode in paragraph 3 above, but do not disclose wherein the functional group is a carboxylic acid.

Fisher et al. discloses a method of making functionalized nanotubes wherein the graphitic nanotubes or fullerenes are functionalized by chemical substitution (see abstract). Fisher et al. also discloses the use of a polycarboxylic acid in the process to functionalize the carbon nanotubes (column 7 lines 32-41). Therefore, at the time of the

Art Unit: 1795

invention, it would have been obvious to one of ordinary skill in the art to use a carboxylic acid to functionalize the electrode of Smalley et al. and Hampden-Smith et al., because Fisher et al. teaches the presence of the carboxylic acid aiding in the linking of nanotubes to form a mat or lattice layout (column 7 lines 32-46).

### ***Response to Arguments***

5. Applicant's arguments with respect to claims 1, 4, 6, 8-17 and 63, have been considered but are moot in view of the new ground(s) of rejection. The rejections of record are based on the claims, as amended.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Karie O'Neill whose telephone number is (571)272-8614. The examiner can normally be reached on Monday through Friday from 8am to 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.



Art Unit: 1795

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Karie O'Neill  
Examiner  
Art Unit 1795

KAO

/Mark Ruthkosky/  
Primary Examiner, Art Unit 1795